that the foot rested upon the sole. He had also shown that while the primitive types possessed cone-shaped teeth, the more differentiated they became the more complex the teeth were. An interesting statement in regard to the dental formulas of various orders was given. Without going into details, it may be said that the speaker argued for the three great groups of mammals,—monotremes, marsupials and placentals,—a common origin far back of Jurassic times, for the three were then plainly differentiated. These classes arose from a promammalian type, which was, in its turn, an offshoot from a still simpler form, a second offshoot from which developed into the reptilian type of life. The horse he considered as originating on the North American continent, and he pointed out the interesting fact that the disappearance of many of the huge forms of mammals that once peopled our western plains seemed co-incident with the introduction of grasses.

Professor Bessey, before Section G (Botany), gave an excellent address upon classification. He pointed out the anomalous fact that while botanists have long recognized that the present scheme of classification was defective, they still adhered to it. Theoretically discarding it, practically they used it. He showed that there may be degradation as well as advancement in evolution, and that what seemed the lowest forms of dicotyledons, from their floral structure, were not necessarily primitive types. He therefore interpolated the apetalous orders of the ordinary classifications among the polypetalæ, as degraded types of polypetalous flowers. He outlined what seemed to him to be a natural classification, considering the Ranunculaceæ as the most primitive flowers. The greatest deviation, therefore, from this type was the highest in organization. He believed that with but little modification the sequence of orders in our modern text books could be used to express the natural relationships of plants. Of course such a scheme as a lineal arrangement was out of the question. He, in common with many others, recognized the Compositæ as the most highly organized of the dicotyledons, and the Orchideæ were placed at the head of the monocotyledons.

In the general session of Thursday evening the retiring president, Professor LeConte, of California, delivered an address upon the "Origin of Mountains." In opening, he defined a mountain as the result of a single earth effort, occupying a short or a very long time, while a mountain range was the result of a succession of earth throes. The thickness of the strata of mountains varies, but it is always great. In the Appalachians the Paleozoic is 40,000 feet thick. The Mesozoic of the Alps is 50,000 feet, and the Cretaceous of California is 20,000 feet. The sediments of the Appalachians thin out to the west to only one or two thousand feet, so that mountains may be considered as lines of exceptionally thick sediments. They are, at the same time, lines of exceptionally coarse sediments. Foldings and faults are also characteristic of these features of the earth, the folds being single or many, and the faults being sometimes of enormous extent. Faults of 20,000 feet occur in our western region. After this general discussion of features, the causes were considered. There are both formal and physical explanations. The first explain the cause from the geologists' point of view, and the second from that of the physicist. The first may explain one or more of the phenomena, but the last must explain all of them. Various illustrations were given of these, and then the formal explanation of facts was taken up. Mountains are born of sea-margin deposits, the loaded sea bottoms inducing sinking of the denuded land surface, and the mountains are formed by lateral crushing and upthrust. He did not believe in the theory of a liquid interior, with a solid crust, stating that a globe as solid as glass or steel would assume the oblate spheroid form, as the result of rotation. He argued at length in favor of the lateral thrust origin of mountains, and examined objections urged against it. He also outlined other theories of mountain origin, and pointed out their defects, declaring, however, his entire willingness to give up his theory whenever any better one had been presented.

THE CORNELL MIXTURE.

BY M. V. SLINGERLAND, CORNELL EXPERIMENT STATION, ITHACA, N. Y.

Last winter, while experimenting in the making of the different insecticides and fungicides, I succeeded in forming a combination which, at the time, seemed to be an almost perfect panacea for all the insect and fungoid ills that might affect the fruit grower. When it was shown to Professor Bailey he immediately dubbed it "The Cornell Compound or Mixture."

In making the mixture I combined the following well-known insecticides and fungicides: Paris green, kerosene emulsion and Bordeaux mixture. Simple enough, was it not? And what a field of possibilities and probabilities it seemed to cover when the theory of the combination is rightly understood. In the Paris green (which I prefer to London purple, on account of its containing less soluble arsenic, and is thus less liable to injure tender foliage, and still better, the copper of the Paris green gives it noticeable fungicidal properties) we have the best, cheapest and most practicable insecticide for all biting or chewing insects like the codlin moth, the potato beetle, and all the leaf-eating caterpillars and beetles. The kerosene emulsion is also well known as the best, cheapest and most practicable insecticide for general use against all insects which obtain their food by sucking it through slender beaks with which they pierce the tissues of the plant. Familiar examples of this group of insects are the pear psylla, the plant-lice and the squash bug. And finally, the Bordeau mixture, which now ranks first among the fungicides in effectiveness against the worst fungoid diseases, like the apple scab, the potato blight and rot, and the plum and peach fruit rot. One can thus understand what a destructive power there seemed to lurk behind the mask of the Cornell mixture.

Many experimenters have shown that when the Bordeaux and Paris green are combined, the destructive effect of neither is lessened, and we know that the lime of the Bordeaux mixture converts all of the soluble arsenic of the Paris green into an insoluble compound, thus allowing the use of the arsenite at nearly twice the strength usually used without danger to tender foliage. The two are easily combined and are to be recommended for general use.

Attempts have been made to combine the insecticides Paris green for biting insects, and kerosene emulsion for sucking insects, but without success; the arsenite cannot be made to unite satisfactorily with the oily lighter emulsion. I have seen no accounts of any trials to combine the Bordeaux mixture with kerosene emulsion. Such a combination strongly recommends itself to pear growers especially, who have the pear psylla to fight, and who wish to exterminate the scab at the same time. My experiments in this line were suggested by a large pear grower who had these foes to meet.

My Bordeaux and emulsion were made according to the directions which are appended below.* When the directions were carefully followed I found that I could quite readily combine the two in any proportions required, and the resulting mixture remained stable for weeks; and in fact the Bordeaux, as a mechanical mixture, was improved, for the emulsion held the lime in suspension, so that its tendency to settle to the bottom, and thus require con-

stant stirring, was reduced to a minimum. The addition of the Paris green to the Bordeaux before the emulsion was put in did not visibly affect the mixture. Up to this point, therefore, the combination was a success. It now remained to be seen how it would stand a practical test by the ordinary fruit grower in the field. Theoretically, the chances were all in its favor.

However, further experimentation at the Insectary showed that unless the Bordeaux was rightly made, the emulsion would not form a stable combination with it, and in fact sometimes would scarcely mix at all. It was found that the best combination was obtained when the acid copper sulphate solution of the Bordeaux was exactly neutralized by the alkaline lime; the potassium ferrocyanide was the test to determine when this point was reached. Thus, when the Bordeaux was made in the usual way without testing, nine times out of ten the emulsion would not mix with it satisfactorily. Here, then, was the first obstacle to the Cornell mixture,—the difficulty of making it.

In the spring I saw it made and applied on a large scale, with horse power sprayers. As far as the making and application were concerned, it was a success. It worked as easily through the sprayer and nozzle as the Bordeaux alone. But an examination of the trees after the sprayer had passed showed that the mixture had not spread so evenly over the tree as would either of the ingredients alone. And right here, I believe, is the weakest point in the Cornell mixture. The spray was thrown fine enough, but when it struck the trees the minute particles seemed to be drawn together into larger oily drops, leaving considerable areas unwet. There is a tendency in the Bordeaux mixture alone to do this, but it was increased by the oil in the emulsion.

One can easily imagine with what regret I am thus obliged to tear the mask from off my theoretically complete panacea. When first concocted it seemed equal to all that might be claimed for it, and it was thought best to publish it at once; but, realizing that it ought to be first fully tested in a practical manner, it was put into the hands of two or three large fruit growers with the results which I have detailed above. On the whole, the Cornell mixture, *theoretically*, has great possibilities, and in the hands of careful men can be made, but for the ordinary fruit grower or farmer the difficulty of making it will render it impracticable. And when properly made and applied it will be quite effective, each ingredient for the purpose it is intended. But I believe the effectiveness of each ingredient will be greater if they are not applied in combination, but singly. Thus, theoretically, the Cornell mixture has great possibilities, but, besides the difficulty of making, the effectiveness of each ingredient is lessened, and in consequence the practicability of the mixture is as yet doubtful, and I cannot freely recommend it for general use.

*To make the Bordeaux mixture, dissolve six pounds of sulphate of copper in four or five gallons of hot water. Slake four pounds of quick lime in sufficient water to form a thin whitewash and strain this through a gunny sack (burlap) into the copper sulphate solution. Dilute to forty gallons with water, and the mixture is ready for use. When using, it must be kept thoroughly stirred to keep the lime in suspension. The preparation of the mixture in large quantities may be simplified by a test which obviates the necessity of weighing the lime. Keep the mixture thoroughly stirred when the thin whitewash of slaked lime is being poured through the burlap, and add from time to time a drop or two of the commercial potassium ferrocyanide to the mixture. If not enough lime has been added the drop of ferrocyanide will turn to a very dark color the moment it touches the mixture; when enough lime has been added, the ferrocyanide will not change color when it is dropped into the mixture.

To make the emulsion, thoroughly dissolve one-half pound hard or soft soap in one gallon boiling water. While this solution is still very hot add two gallons of kerosene and quickly begin to agitate the whole mass through a syringe or force-pump, drawing the liquid into the pump and forcing it back into the dish. Continue this for five minutes, or until the whole mass assumes a creamy color and consistency which will adhere to the sides of the vessel, and not glide off like oil. It may now be readily diluted with cold rain water, or the whole mass may be allowed to cool when it has a semi-solid form, not unlike loppered milk. This standard emulsion, if covered and placed in a cool dark place, will keep for a long time. In making a dilution from this cold emulsion, it is necessary to dissolve the amount required in three or four parts of boiling water, after which cold rain water may be dded in the required quantities.

CHEMISTRY IN CANE SUGAR MANUFACTURE.

BY J. T. CRAWLEY, SUGARLAND, TEXAS.

During recent years the part played by chemistry in the manufacture of sugar from the sugar cane has become an important one, cane sugar manufacture is older than beet sugar manufacture, but it remained for those interested in the latter to work out the practical and scientific questions that make the industry of such vast importance at the present time. It is only in recent years that the same scientific principles have been applied in tropical countries in the field and in the factory. Important among the recent improvements has been the application of chemistry to the better understanding of the various changes that the raw material may undergo while being converted into refined products.

When the cane is brought from the fields it is weighed, and then, in most cases, is passed between immense iron rollers where the juice is expressed. By recent improvements in mills the per cent of juice actually obtained, has increased from the neighborhood of 65 per cent to from 75 to 80 per cent.

This great improvement has been made of course by the engineer, but it is safe to say that without the aid of the chemist in calling attention to the immense losses in the bagasse these improvements would have been delayed many years.

After expression the juice is either weighed or measured and then the real work of chemistry begins. Because of the changes that the contained sucrose may undergo during subsequent processes the juice is analysed for sucrose, glucose, total solids, ratio of sucrose to glucose and ratio of sucrose to the total solid matter. This gives, by proper calculations, the total amount of the various ingredients entering the factory with the various ratios one to the other. These ingredients with their ratios must be watched very closely to see that impurities are not formed at the expense of the cane sugar. Lime is added to the raw juice for the purpose of neutralizing the acids contained therein, and in order to purge it of many of the impurities that would interfere with the subsequent crystallization of sugar. Here again a strict watch must be kept. An insufficient quantity of lime leaves free acids in the juice and these same acids will act upon the sucrose changing it into glucose, or inverted sugar, during the evaporation of the juice and syrup. Analyses are made of clarified juice, syrup, massecuite, etc., and from these analyses together with the weights of these various products the chemist is enabled to detect any important loss that has been sustained, whether it be chemical or mechanical, and from a scientific examination of the data thus furnished the manufacturer is enabled to so modify the various processes as to get the best results, finally the sugar and molasses are analysed, and thus a complete record is had of the whole process from the entering of the cane to the final output of sugar and molasses. It will thus be seen that the chemist is the book-keeper, so to speak, of the sugar during the process of manufacture, and it is his business to point out losses, and, if possible, suggest remedies. It is a rare case, however, to find a factory in Louisiana where a strict chemical control, such as has here been outlined, is maintained.

The great amount of labor necessary, together with the cost of weighing and measuring apparatus, has prevented the majority of factories from adopting such a complete system as will tell them the efficiency of their work. But in these days of sharp competition the fact is gradually impressing itself that science must not be overlooked, and that it is of vast assistance even where money-making is the only end.